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The WESTINGHOUSE COMPANIES *at the* INTERNATIONAL RAILWAY CONGRESS

A Group in the Westinghouse Pavilion

(Taken by the Cooper Hewitt Light)

George A. Post
Chairman of Exhibition Committee

George Westinghouse

Charles W. Fairbanks
Vice-President of the United States

J. Alexander Brown
Director of Exhibits

The WESTINGHOUSE COMPANIES EXHIBITS *at the* INTERNATIONAL RAILWAY CONGRESS, WASHINGTON NINETEEN HUNDRED *and* FIVE

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Wilmerding, Pa.

Prepared by
Wallace M. Probasco
New York

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THE first session in America of the International Railway Congress and the seventh session of that body was held at Washington, the Capital of the United States, May three to thirteen, nineteen hundred and five. On so notable an occasion it was eminently fitting that the display of American railway appliances installed on the Washington Monument grounds for the inspection of the delegates should have been the most complete manufacturers' exhibit ever assembled as a feature of a temporary convention. The industrial exhibition has become an essential part of meetings of associations concerned with engineering progress. This feature assumed a new dignity in the American Railway Appliance Exhibition at Washington, which was planned and executed in a spirit of international courtesy, and to the distinguished heads of a great industry assembled from all parts of the world it afforded a comprehensive object lesson of America's inventive contributions to the field of their efforts.

The International Railway Congress of nineteen hundred and five recorded many engineering achievements in railway development, and marked the advent of a new era in transportation. It is as a motive power that electricity is most rapidly increasing in importance. The manufacturers' exhibition at Washington earned an exceptional place in the history of railway science in its operative demonstration of the merits of improved appliances, methods, and machinery for the better, safer and more comfortable operation of railways, and in the simplicity and economy of the latest types of electric traction systems.

Attendance at the regular sessions of a serious deliberative assembly, however, seldom leaves time for a thorough study of the industrial exhibits, and the visiting delegates, as well as those unable to register at conventions to which they have been appointed, must look to the future for a final understanding and appreciation of the products to which their attention has been attracted. The broad scope of the Washington exhibits, and their novelty and variety, made the problem of the foreign delegates at the International Railway Congress a peculiarly difficult one in this respect. For the further information of those who were interested in the Westinghouse exhibits at New York, Washington, and East Pittsburg, and for the pleasure and profit of those who were unable to attend the congress, this souvenir is presented with the compliments of the Westinghouse companies.

THE WESTINGHOUSE COMPANIES

THE exhibits of the Westinghouse companies at the International Railway Congress began on the arrival of the delegates in New York with the inspection of the power plants, train equipment and signal devices of the Interborough Rapid Transit Company's elevated and subway lines, and of the other important metropolitan railway systems. At Washington, the Westinghouse products presented the most notable collection of railway appliances ever shown by a single exhibitor. At East Pittsburg, after the close of the congress, the visit of the delegates to the works of the Westinghouse Air Brake Company, the Westinghouse Electric and Manufacturing Company, and of the Westinghouse Machine Company, was the occasion for the introductory exhibition of the improved Westinghouse air brake triple valve, and of the first large single-phase electric locomotive ever built.

The Westinghouse pavilion at Washington was the largest of the exhibition structures apart from the headquarters building, and presented, in an attractive arrangement, examples of practically all the important products of the American Westinghouse companies applicable to railway service. The dome was lighted with four long electric signs which flashed the name "Westinghouse" to great distances, and near the entrances banners carried the names of the twenty-six Westinghouse companies of America and Europe which supply Westinghouse products to all parts of the world through a carefully arranged division of territory designed to ensure their manufacture and marketing under conditions of the greatest economy.

The Westinghouse companies have an army of over 30,000 employees. Their shops and forges and general executive offices are located in seven States of the United States, in the Dominion of Canada, in England, in Russia, in Germany, and in France; and 105 branch offices and special agencies are maintained in sixty-eight cities of North and South America, Europe, Asia, Africa and Australia. These companies were the largest exhibitors at the Louisiana Purchase Exposition of 1904, and it was a Westinghouse generating plant that supplied light and power to the exposition. The floor space of the works that were represented was 142 acres, or an area greater than that occupied by the twelve great exhibition palaces of the exposition. The Westinghouse awards at St. Louis, including a special award for the "best, most complete, and most attractive exhibit," and twelve grand prizes, were the most comprehensive list of highest honors ever bestowed upon one individual name at a world's fair.

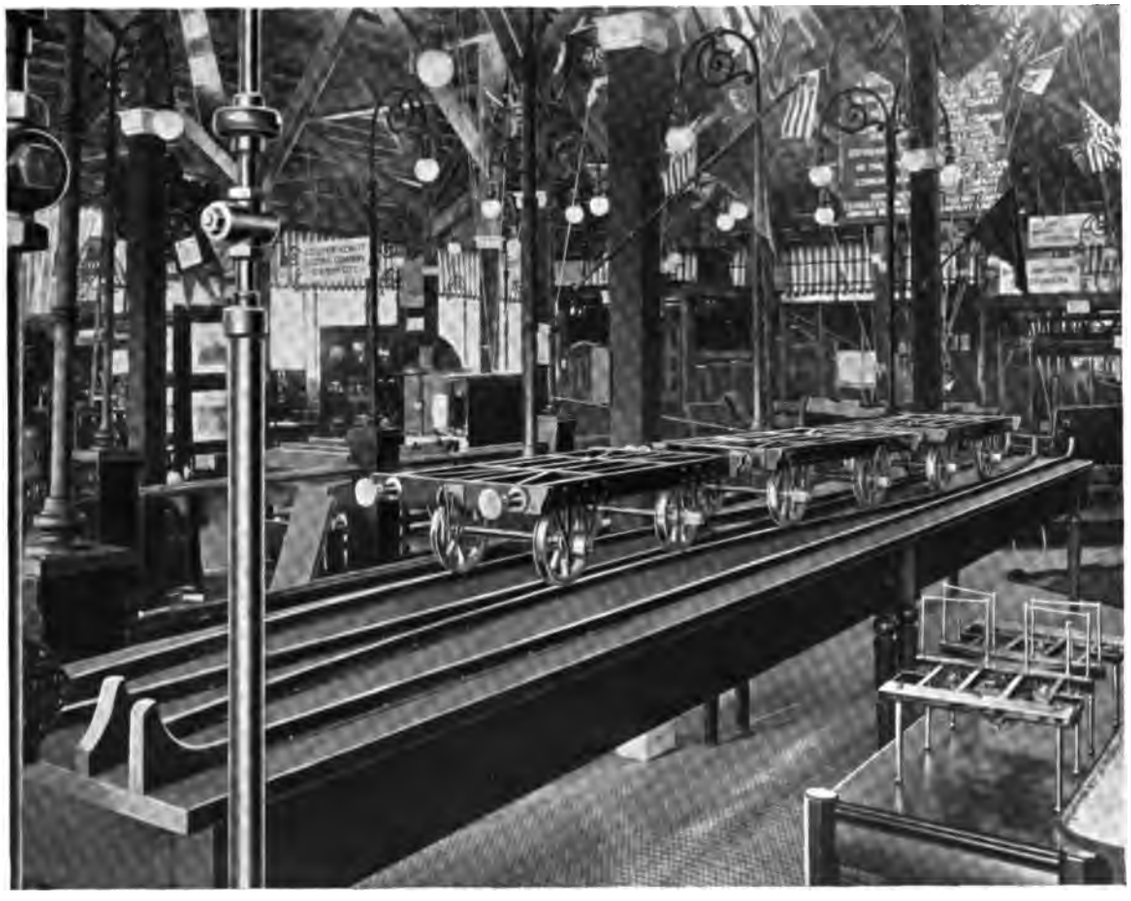
Westinghouse products include railway brakes, coupler appliances, and friction draft gear; switching and signaling devices; air compressors; gears, pinions and trolleys; electrical machinery, instruments and controlling apparatus; standard electrical fittings; incandescent, arc, Nernst and Cooper Hewitt lamps; gas and water meters; Roney mechanical stokers; steam engines, steam turbines, and gas engines; and gasoline automobiles. All the American Westinghouse works were represented at Washington by exhibitions of these products, and Westinghouse Church Kerr & Company, engineers, whose activities are directed wholly toward the investigation, design and construction of power, industrial and transportation properties, was represented by large photographic illustrations and drawings of work done.

The Westinghouse Pavilion at Night

WESTINGHOUSE brakes, first manufactured at Pittsburg nearly two generations ago, have played such an important part in the advancement of railway science, and have universally become so essential a feature of railway equipment, that the comprehensive exhibits of Westinghouse railway safety appliances were of pre-eminent interest to many of the delegates to the congress. The Westinghouse Air Brake Company, organized in 1869, was the first of the Westinghouse companies, and had earned a high reputation for Westinghouse products around the world long before the appearance of the first Westinghouse engine or generator. Its main works at Wilmerding, Pennsylvania, fifteen miles east of the Pittsburg Union Station, have 3000 employees and a capacity of 1000 brake sets a day. Its chief operative exhibit at Washington was the famous Westinghouse instruction car, which has been used throughout the United States and Canada in the instruction of more than 200,000 railroad employees. Complete operative demonstrations of the various Westinghouse brake and train-signal systems for

passenger and freight service were given in this car, on the tracks near the Monument grounds, by the company's regular instruction corps. In the Westinghouse pavilion, the display included sectional models of Westinghouse brake valves, governors, and cylinders, and of improved types of Westinghouse steam-driven air pumps for railway and industrial service, and operative exhibits of the Westinghouse friction draft gear; of a new Westinghouse device for the automatic coupling of the drawbar, brake, and electrical connections between cars in electric traction service; of the electric railway brakes and motor-driven air compressors of the Westinghouse Traction Brake Company, also manufactured at the Wilmerding plant of the Westinghouse Air Brake Company; of the locomotive brake equipments and automatic slack adjusters of the American Brake Company; and the automatic railway hose couplers of the Westinghouse Automatic Air and Steam Coupler Company, affiliated institutions, with factories at St. Louis, Missouri; and of full-size installations of all standard types of the safety apparatus of the Union Switch and Signal Company.

The products represented in these exhibits are also manufactured or sold abroad by the Westinghouse Brake Company, Limited, which supplies Westinghouse railway safety appliances to all of Europe except France, Russia, Belgium, Switzerland, Spain, Portugal, Holland and Italy, from factories in London and Hanover; by the Canadian



Electric Traction Coupler Model—Brake Exhibits

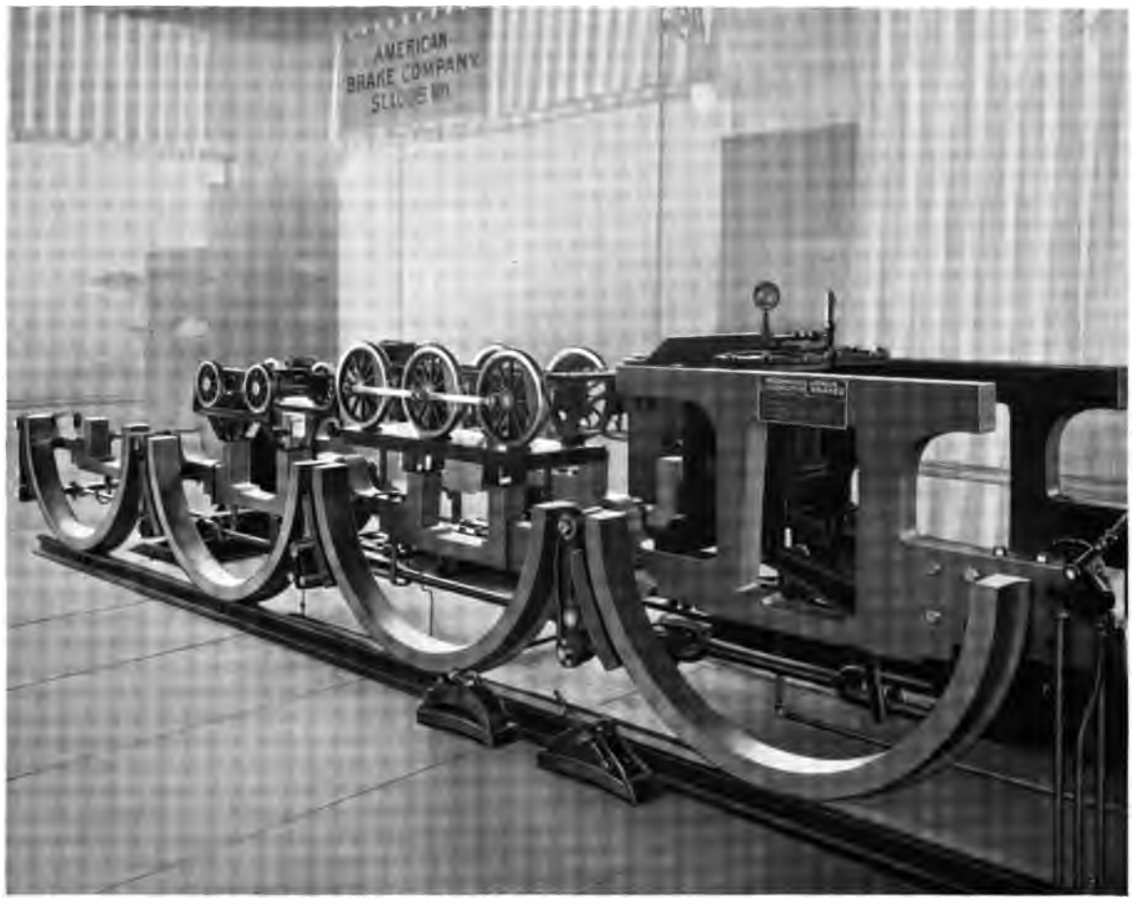
View of Main Aisle—Westinghouse Pavilion

Westinghouse Company, Limited, which supplies Canada from its works at Hamilton, Ontario; by the Société Anonyme Westinghouse, which supplies France, Belgium, Switzerland, Spain, Portugal, Holland and Italy, and their colonies and protectorates, from its works at Freinville, France; and by the Société Anonyme Westinghouse, which supplies the Russian Empire in Europe and Asia from its works at St. Petersburg. The demonstration of the Westinghouse high-speed brake, which has been adopted in the fast passenger service of America more quickly than in that of other countries, was naturally of unusual interest to delegates from abroad. The advent of the Westinghouse air brake in 1869 heralded a new era in transportation in which the question of speed was to become one of locomotive efficiency and economy rather than of control, and it was inevitable that its introduction should have encouraged the establishment of new standards of locomotive and coach construction for higher speeds and greater power, and for the better protection and increased comfort of the passenger. Improvements in Westinghouse braking methods, announced from time to time, have anticipated each important requirement of railroad development, and the operative demonstration at Washington of the high-speed brake equipment strikingly directed attention to the rapid extension of fast railway schedules which has made the application of increased braking power, properly controlled, so desirable in general passenger service.

Baltimore and Ohio Railroad's 240-ton Articulating Compound Locomotive Equipped with Air Brake Apparatus

The Westinghouse high-speed brake, with which about 30,000 locomotives and passenger cars have been equipped to date, permits the effective use of a braking pressure for high speeds forty per cent. greater than the maximum of ordinary practice, and a safe increase of sixty per cent. in auxiliary reservoir pressure to augment the general storage capacity of the brake equipment for repeated service stops or long brake applications on down-grade runs. The high-speed equipment differs from the ordinary quick-action apparatus only in the addition of an automatic reducing valve connected to each brake cylinder, which is inert in all service applications of the brake except when the cylinder pressure exceeds 60 pounds, whereupon it operates quickly to discharge the

Steam-driven Air Pumps, Compound Pump on Left

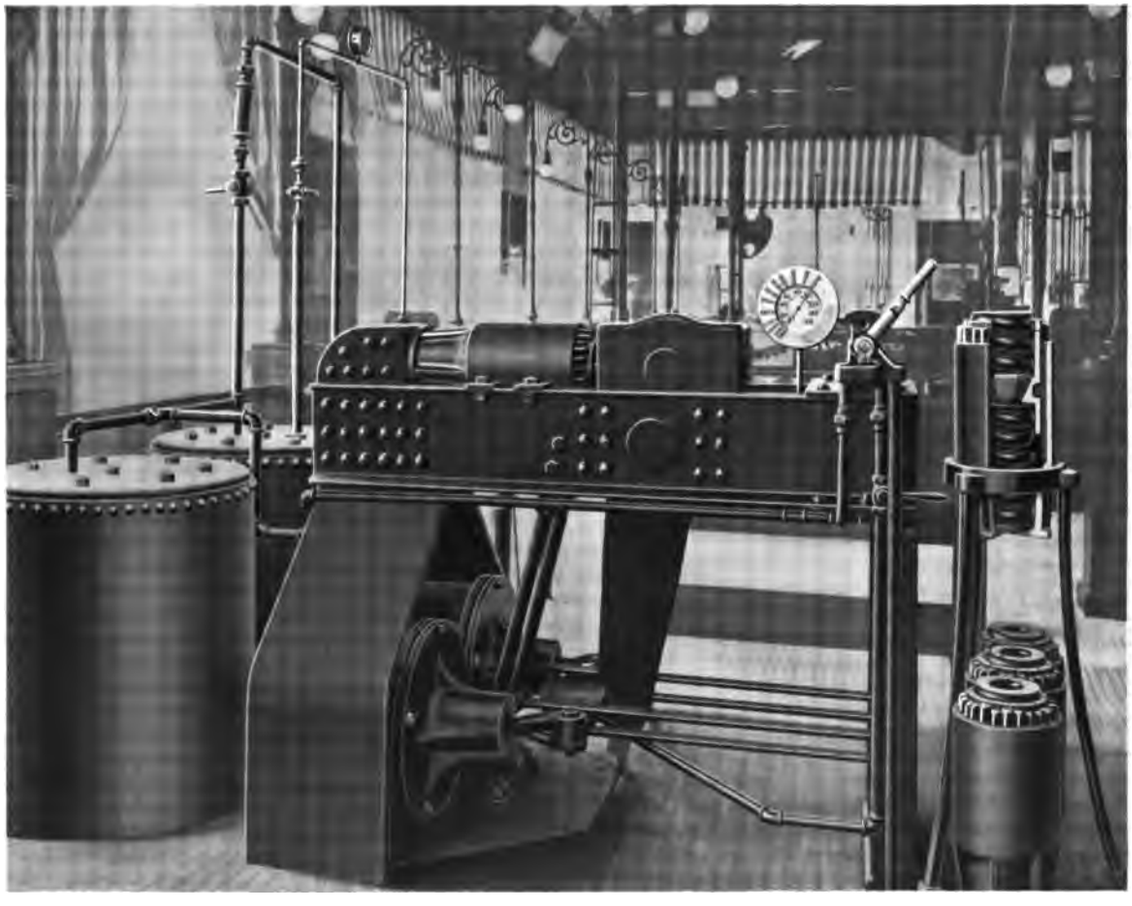


Models of Westinghouse-American Driver Brakes

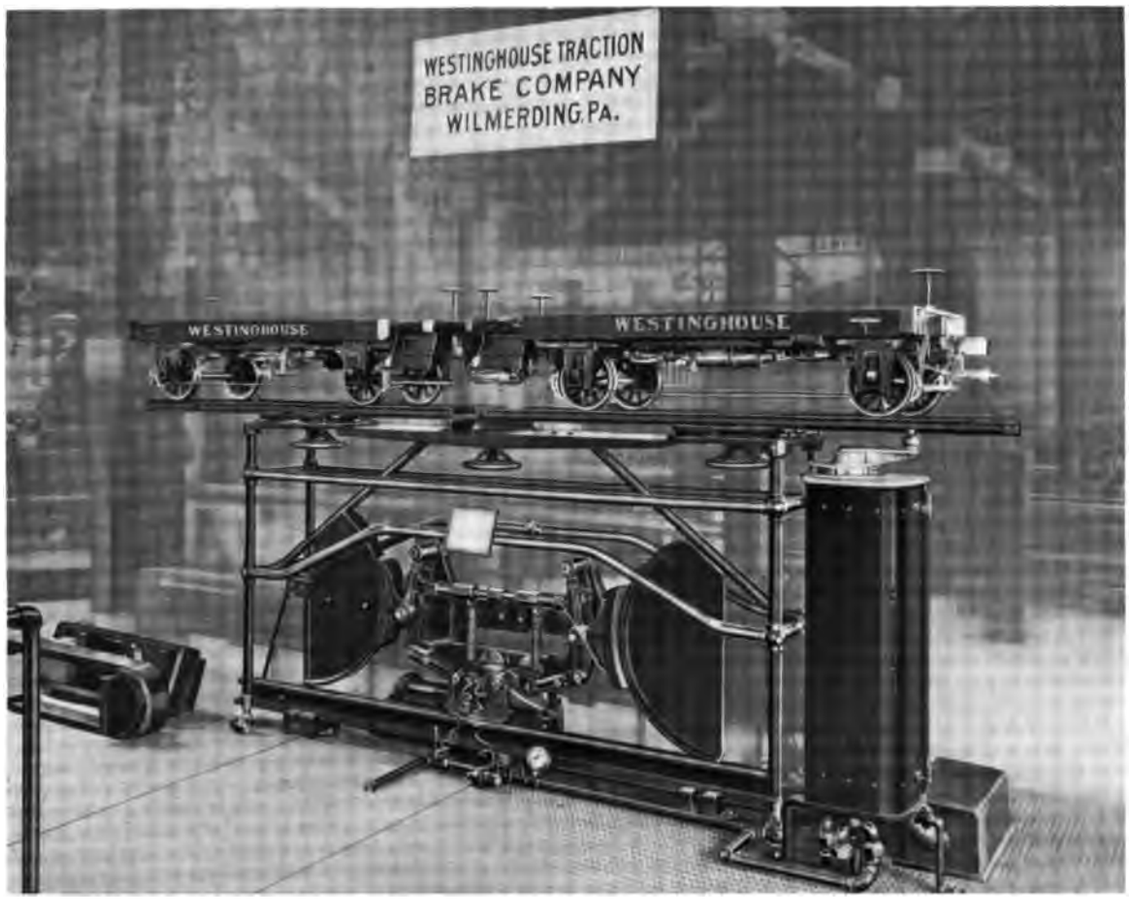
surplus pressure; but in an emergency application of the brakes the admission of air into the brake cylinders from both the auxiliary reservoirs and the train line is through openings so much larger than the exhaust ports of the reducing valves that the excess pressure is reduced gradually, and is maintained for a length of time sufficient for the slackening of the train's speed to a speed at which the 60-pound limit is the maximum efficient pressure. In service applications, of course, the automatic release of any pressure above the ordinary fixed limit ensures an even diffusion of retarding force throughout the train not otherwise obtainable.

Additional special parts on the locomotive—one slide valve feed valve; one feed valve pipe bracket; one reversing cock; two high-speed reducing valves—provide a simple means of cutting off the high-speed pressure so that trains which include cars not equipped with the automatic reducing valve may be run under conditions of ordinary service, or temporary provision may be made for the operation of such cars at high speeds by screwing into the oiling hole of the cylinder head on each car a special safety valve which may be removed at will. The entire high-speed brake apparatus, as exhibited at Washington, is an interesting example of the Westinghouse Air Brake Company's well-known policy of harmonizing all its improved devices with equipment already in service, by simple and effective attachments to former standards.

The exhibit of the Westinghouse tandem compound air pump, only recently applied to American railway practice, was of particular interest in connection with the high-speed brake demonstration. As the work of the locomotive pump has been increased by the rapid increase in the weight and length of trains and by the advent of the high-speed brake, its consumption of steam has become an item of some importance, and the compound pump, which requires for the compression of free air only about forty-five per cent. of that required by the standard 11-inch pump, and effects a still greater saving in high-pressure service, promises a considerable fuel economy. In general appearance, although somewhat longer, it resembles the single air cylinder pump, but has three cylinders placed vertically in tandem—the two lower ones, joined by a thin center piece, constituting the air end, and the upper one a steam cylinder of the regular Westinghouse type. The two air cylinders are of the same diameter, 11 inches, but the steam cylinder, to effect a steam economy, is only 8 inches in diameter. The two air cylinders each have a piston connected to the steam piston rod, and are further connected by a drum of smaller diameter than the inside of the cylinders, the two air pistons and this drum forming a sort of spool about which the center piece between the air cylinders fits closely to prevent the passage of air. The low-pressure air is drawn into the top of the upper cylinder, and the bottom of the lower cylinder, and during compression is forced through suitable



Friction Draft Gear Testing Rack, 160,000 Pounds Pressure



Operative Exhibit of Magnetic Traction Brake, Surmounted by Car Models Equipped with Air Brakes and Automatic Hose Couplers

valves and passages to the annular volume formed between the spool, air cylinder walls, and center piece. The final compression takes place in this annular volume, and the air is forced out through the passages and valves in the center piece to the discharge opening, the pressures on the air piston as a whole being double-acting, and the opportunity for heat radiation and consequent reduction of temperature of the air discharge being twice that of the simple pump because the total air cylinder surface of the compound pump is of twice the area.

The exhibit of the well-known Westinghouse friction draft gear, with which about 120,000 freight cars and over 5000 locomotive tenders have been equipped to date, comprised a testing rack on which the friction gear was compressed with an air force of approximately 150,000 pounds, and sectional models to show clearly the friction device, and the arrangement of the preliminary springs, which receive the first strains of buffing or pulling, and of the release springs, which return the iron segments

Freight Car Brake Cylinder

Operative Exhibit of the Westinghouse Automatic Air and Steam Coupler

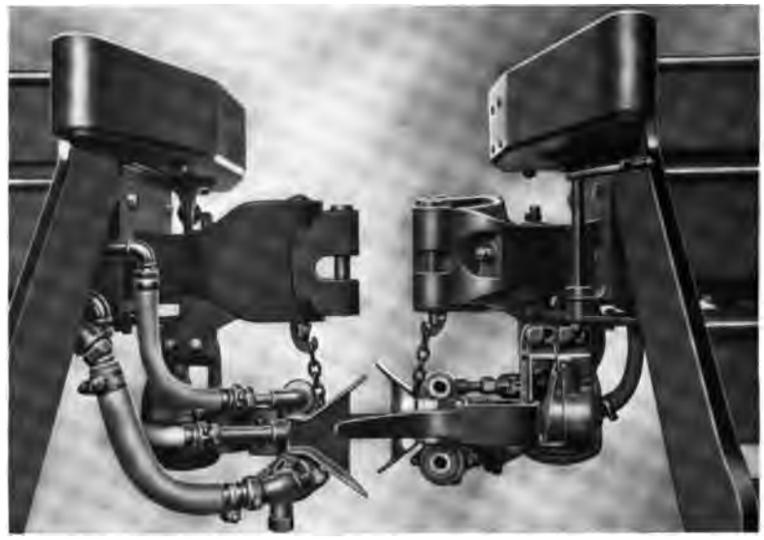
and friction strips of the gear to their normal position after impact. The testing rack afforded an excellent demonstration of the slow and serial release of these segments and strips, without recoil—a feature of great importance in the Westinghouse device in that it eliminates wholly the possibility of the parting of trains either by the quick release of the draft gear from compressive strain, or by direct tensile strain in starting.

The display of the Westinghouse Traction Brake Company, which supplies Westinghouse air brake equipments adapted to all classes of electric railway service, included an interesting exhibit of the Westinghouse magnetic brake, which is operated by power derived from the motors of an electric car driven as generators by the momentum of the car after the line current has been cut off. In all service where heavy grades are encountered, the magnetic brake's superior feature of automatic speed control has been clearly demonstrated, and in England, where this brake has been widely adopted, its popularity has steadily increased.

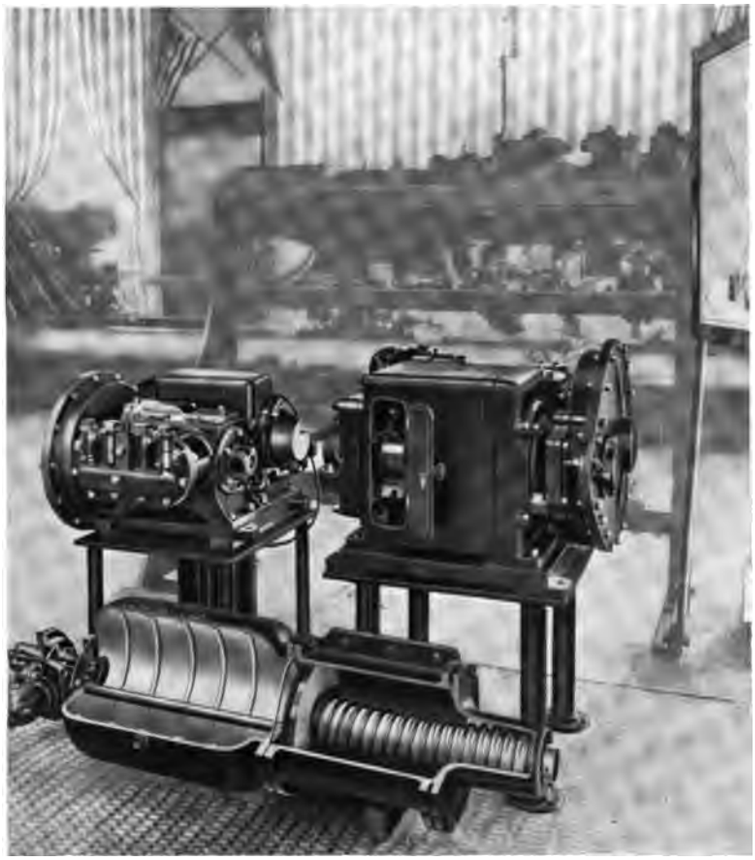
The exhibits of the American Brake Company included full-size models of Westinghouse-American driver brake equipments and sectional models of the American automatic slack adjuster, a simple device for automatically taking up the slack in the foundation brake gear which far excels any other mechanism designed for that purpose.

THE operative demonstration of the Westinghouse automatic air and steam coupler, which has been in effective use on various American railroads, East and West, for some time past, was of novel interest to delegates from Europe, where confusion of drawbar standards has delayed its adoption. The device was exhibited on full-size models of two short car platforms arranged to represent the ends of passenger and freight cars, together with a locomotive pilot. These cars and pilot were provided with air and steam connections, one car platform being so mounted as to permit a variation of four inches in its height and a propulsion at considerable momentum toward either the pilot on one end or the other car platform on the other. Provision was also made for the illustration of successful hose couplings at extreme curves. A miniature model of two complete car trucks and frames fitted with brake and steam and signal hose couplings and air cylinders supplemented the heavy exhibit, and both were in constant operation. The substitution of unfailing mechanical device for slow and uncertain hand process has had much to do with the

railroad progress of the past half century. The air brake, safeguarding the traveler at new high speeds, and the automatic car coupler, protecting the railroad worker against unnecessary danger to life, and effecting also a radical improvement of schedule at terminal stations and elsewhere, attracted general public interest at the time of their introduction and adoption. Quick recognition of the merits of the automatic car coupler had led to inquiry for an automatic device in lieu of the ordinary hand hose couplings for the air and steam connections between cars, and it was natural that the Westinghouse Air Brake Company, which during its existence has equipped with the air brake over 90,000 locomotives and over 2,000,000 passenger and freight cars, should have foreseen the necessity of such a device, and that the result of its experiments should be the only automatic hose coupling device which, after a thorough trial, is accepted as satisfactory. The exhibits of the Westinghouse Automatic Air and Steam Coupler Company at Washington showed in operation, under all exigencies of regular service, a simple, substantial, automatic hose connection which achieves fully the objects



The Westinghouse Automatic Air and Steam Coupler



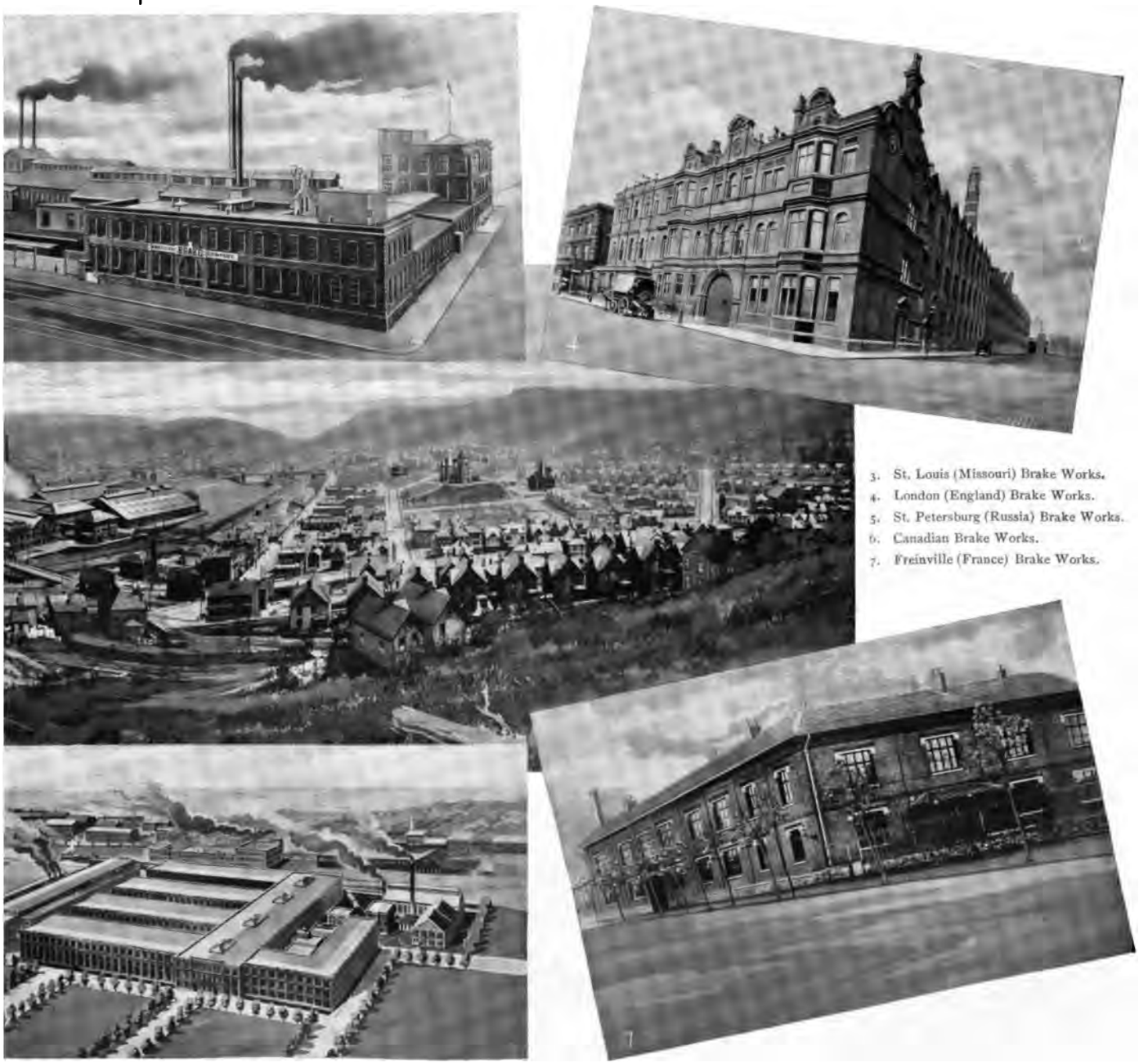
Motor-driven Air Compressors. Automatic Slack Adjuster in Section—on Floor

in view in the endeavor to do away with the common method of hand clamping of intercar hose connections—the elimination of all element of danger to railroad employees engaged in making up and distributing trains, the avoidance of terminal congestion by the saving of time in such work, economy in the use of coupling hose (which the New York Central Railroad has estimated at about fifty-five per cent. of the old cost in hand-clamping practice) and the provision for automatic uncoupling of hose without strain of any kind on the apparatus in the event of the parting of the train by accident.

Westinghouse automatic hose couplings are interchangeable, with no lefts or rights. The coupling head, which is under all conditions protected from injury by the car coupler to which it is attached, is of malleable iron, having V and wedge-shaped guides projecting toward the front, and an outwardly bent spring firmly riveted to the back. It is supported by the coupling spring resting in a slotted buffer hanger, the hanger being bolted to a cast-steel bracket riveted to the drawbar. It is held in position by a chain attached to the drawbar knuckle pin, and will adapt itself in coupling to differences in height of cars or angles of contact which would not permit the operation of the automatic car coupler itself. The buffer hanger embodies a cup-shaped buffing piece held forward by a volute spring, the car coupler itself checking the impact during coupling before the buffer spring of the automatic hose coupling has been fully compressed. The positive engagement of the connections is effected without friction or wear on the gaskets. The automatic drip valve at the lowest point in the steam connection never fails to permit the condensation to escape at a low pressure, so that freezing is entirely avoided. The importance of an interchange arrangement for use in connection with the old hand couplings has not been overlooked, provision being made for accomplishing this in a number

1. Wilmerding, the Home of the Air Brake, Showing the Main Works of The Westinghouse Air Brake Company, Surrounded by the Works of Affiliated Air Brake Companies.
2. Hanover (Germany) Brake Works.

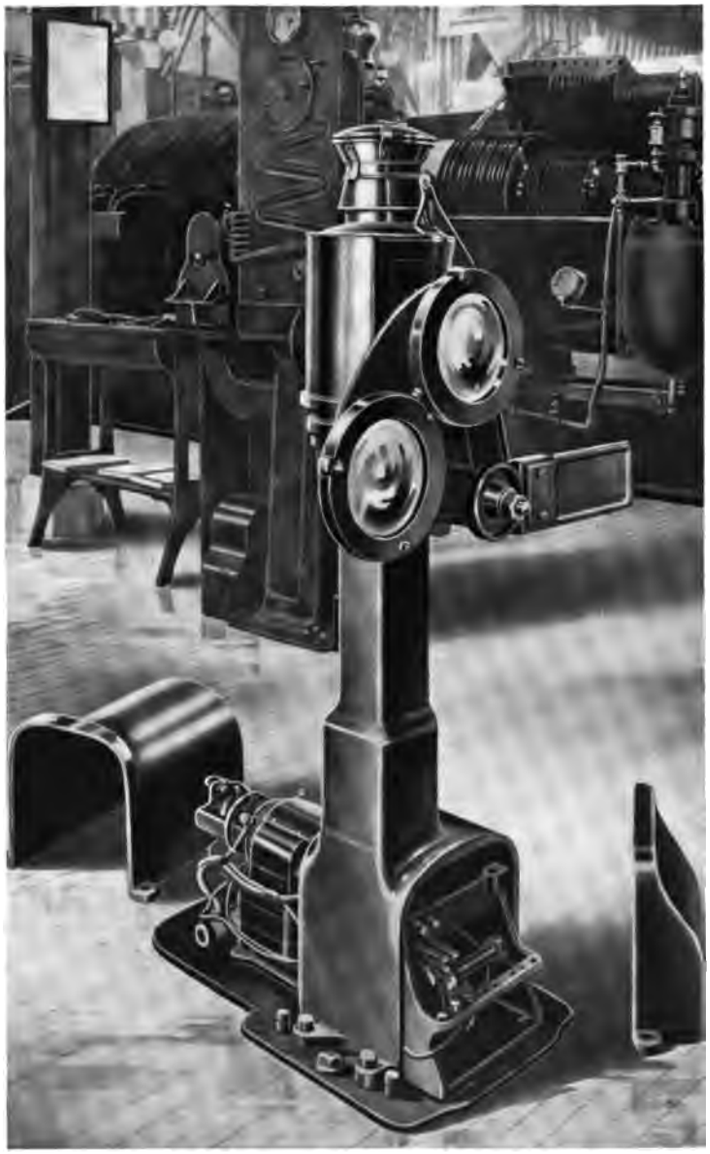
of ways in little more than the time necessary for the usual couplings under the old method. The automatic hose coupler has recently been brought into new prominence as the only device promising a prevention of the high steam losses in train-line service which have been so seriously discussed by railroad economists, and the adoption in the United States of a Federal enactment requiring air brake connections on seventy-five per cent. of all cars in freight train service has given new importance to its features of time economy, which promise the surest possible means of avoiding the schedule delays likely to ensue in train dispatching from the enforcement of such a regulation.



3. St. Louis (Missouri) Brake Works.
4. London (England) Brake Works.
5. St. Petersburg (Russia) Brake Works.
6. Canadian Brake Works.
7. Freinville (France) Brake Works.

THE exhibits of the various automatic and interlocking switching and signal devices of the Union Switch and Signal Company included the well-known types of its electro-pneumatic and all-electric semaphore block signal and high-speed electric train staff systems, new forms of Kopp glass lenses, and a new system of all-electric interlocking of exceptional importance and interest. The exhibit of the company's train staff system attracted special attention in connection with the announcement, just prior to the congress, of the contract awarded for its use in the equipment of about 110 miles of the Southern Pacific Railroad's western line between Rockwell and Truckee with seventy-four high speed absolute instruments and twelve permissive attachments—by far the largest order ever given to that time for a train staff installation.

Electricity as the motive and controling force for both the operation and the indication of the switches and signals in the new Union system of all-electric interlocking, was demonstrated in the exhibit in an operative arrangement of a short track section, complete with a full-sized railroad switch and switch lever, the latter fitted with an automatic device for completing the stroke after the switch had been operated. It has been a comparatively simple matter to adapt electric motors to the operation of switches or signals, but it has been a problem of extreme difficulty to apply the all-electric system for certain and trustworthy operation of lever interlocking for the indication of the switch or signal operations. This problem is satisfactorily solved in the Union system exhibited at Washington by the use of currents of one character for the operation of the switches and signals, and currents of a different character for actuating the mechanism of indication. Direct current is employed for the former purpose, and alternating current for the latter purpose,



All-electric Interlocking Motor-operated Dwarf Signal

The Exhibit of the Union Switch and Signal Company

both being obtained from the same source—generally a storage battery—the direct current being converted into alternating current at the proper time and in the proper circuit by a very simple method adding practically nothing to the cost or complication of the apparatus. The use of currents of different character for operation and indication is an absolute safeguard against the misleading manifestations which might otherwise result from faulty insulation, and the switches and signals are protected against improper movement, which might result from stray currents through faulty or broken-down insulation, by means of a magnet cut-out in connection with each switch and signal, which opens the circuit when a wire leading to it becomes crossed with a live wire. This cut-out acts independently, without affecting any other switch or signal in the system, a decided improvement over anything heretofore used or known for this purpose. The motors for operating the switches and signals are of the revolving armature type, the armatures connected with the mechanism to be moved by means of electro-magnetic clutches, which afford a very simple and reliable means for connecting and disconnecting, and are at the same time a safeguard against shocks to the mechanism which might result from the obstruction of the switchpoints in any way. The lever machine is operated by vertical alternating current motors at the back, equipped with vertical shafts to which are applied ordinary ball governors, the indicating latches on the

lever quadrants being raised when the motors revolve and the governor balls fly apart, and the stroke of the lever being completed manually or automatically.

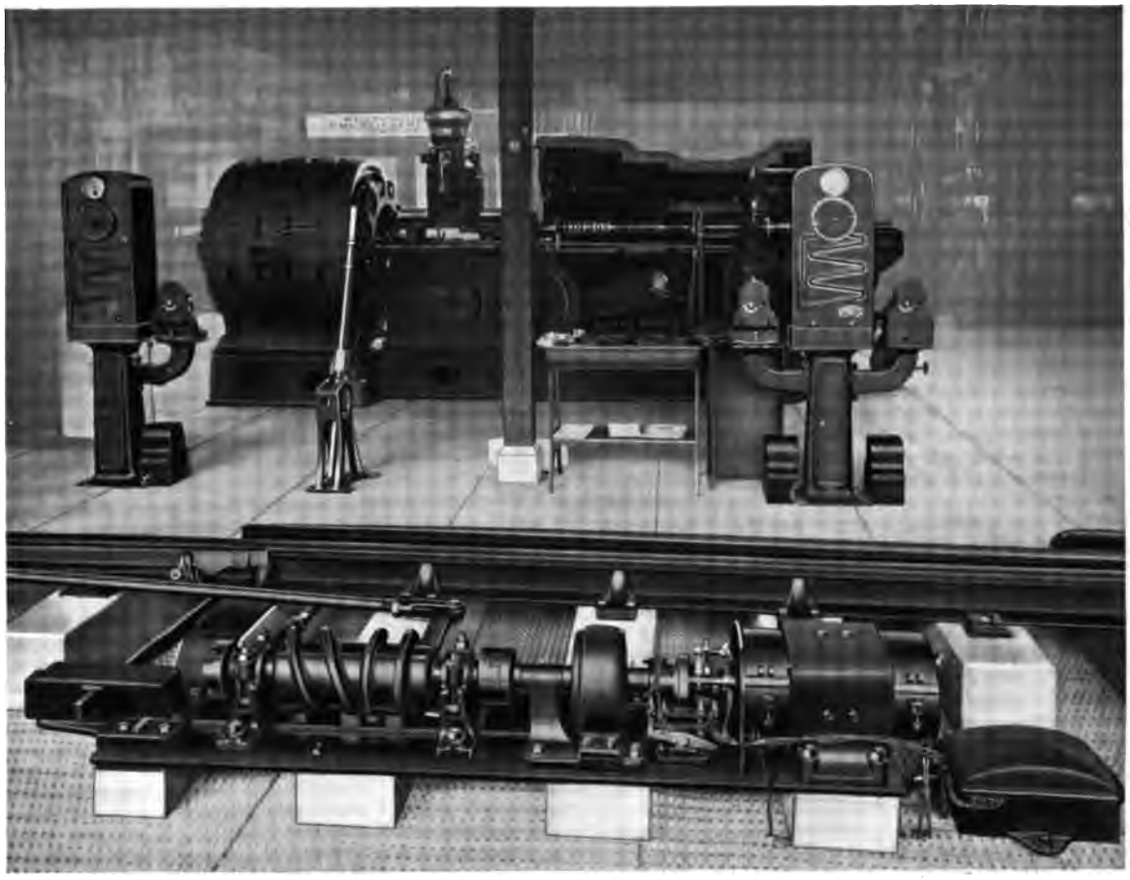
A New York Subway Entrance

Three different forms of Union electric block signal semaphores were included in the operative display: a two-position automatic instrument, a three-position automatic instrument, and a two-arm interlocking signal. The exhibit of Kopp signal glass included important new forms of dioptric lenses, with five steps, to take the place of the lenses of three refraction steps formerly used, the new design being introduced to eliminate the possibility of the distortion of refracting surfaces which sometimes results in old-style lenses through the "settling down" of the three high steps so as to produce concave elevations. The absolute quality of the Kopp "solid-red" signal glass was demonstrated in an interesting manner through the use of the spectroscope pointed at Cooper Hewitt mercury vapor lamps hung overhead. The Cooper Hewitt lamp, as is well known, emits no red rays, and, as the Kopp "solid-red" lenses will transmit no other color, the brilliant actinic light of the mercury lamps was completely obscured when the Kopp glass was placed between it and the spectrum.

Westinghouse switch and signal devices have been widely introduced in all parts of the world, but the acknowledged leadership of the Union Switch and Signal Company in America, and the magnitude and novelty of many of its American terminal installations and of its block signal equipment of the New York subway roads—the most difficult job of signal installation ever undertaken—gave special prominence to the company's exhibits in the Westinghouse pavilion, which were generally regarded as comprising one of the most important displays of improved railway appliances set before the congress. This company's greatest exhibits, however, were its systems in operation over the roads traveled by the delegates and its modern terminal installations, notably at the new South Station, Boston; at the Broad Street Station, Philadelphia; at the Jersey City and Pittsburg terminals of the Pennsylvania Railroad; and at the new Union Station at St. Louis, which has the largest power interlocking system in the world. The St. Louis system includes one Westinghouse interlocking machine of two hundred and fifteen levers which is worked in connection with two smaller Westinghouse machines of similar type.

The New York subway installation furnished an interesting example of the Union electro-pneumatic signal system, with alternating current control, for direct current electric railways, in which a track relay operated by alternating current is not affected by the direct current returning through the track circuit.

Union Signal in New York Subway



All-electric Interlocking Operative Exhibit, Switch Movement, Electric Train Staff in Background

The subway traffic controlled by the Union installation is frequent, heavy, and fast; the quantity of current dealt with is heavy; and the spaces are restricted; but the record of a single month's operation, shortly after the opening of the road, showed 464,694 signal operations for each failure reported, and no failure to the clear position—a record which has never been equaled in any other block signal installation.

The Union Switch and Signal Company was founded by George Westinghouse in 1882. Its new shops at Swissvale, eight miles east of the Pittsburg Union Station, were completed in 1901, and give employment to about fifteen hundred men and to a force of about five hundred men in the field.

This company has taken orders for over four thousand electro-pneumatic interlocking levers, and has sold in the past few years over twelve thousand all-electric signals alone. It is the only company in America manufacturing and installing the electric train staff system, the best general method of signal track blocking. It very early secured control in America of the famous Saxby and Farmer mechanical interlocking patents, and subsequently originated and developed power interlocking, and installed hydraulic and hydro-pneumatic machines. These were followed by the Westinghouse electro-pneumatic machine, which has maintained from the first its standing as the highest development of power interlocking.

THE Westinghouse electric traction exhibits were remarkable as the first complete operative display of both direct current and alternating current motor and control equipments ever made at an exposition. The Westinghouse single-phase alternating current railway system, the most important of America's pioneer contributions to electric traction during the past few years, was of preeminent interest to those delegates to the congress who had watched the uninterrupted progress of the electric railway from its elementary stage of a limited municipal usefulness to its recent wide adoption as a successful competitor of the steam railroad in high-speed interurban service. With the exception of the Swedish Government's tests of a small Westinghouse single-phase locomotive built for trial operation, the first applications of the Westinghouse alternating current railway system had all been in America, so that the car truck exhibit in the Washington pavilion, and the later exhibit of a single-phase electric freight locomotive on the tracks of the Westinghouse Inter-works Railway at East Pittsburg, afforded to most of the delegates from abroad the first illustration of the great possibilities of the new system in the final evolution of electric traction as a substitute for steam locomotion in important long-distance traffic. The significance of the Westinghouse electric traction exhibits at Washington was strikingly emphasized shortly after the close of the congress by the order placed by the New York, New Haven and Hartford Railroad for twenty-five Westinghouse single-phase locomotives, the most interesting step of the past ten years in railway and electrical progress. While the New Haven locomotives will be used at first mainly over the direct current electric lines of the transformed New York Central terminal system, it was chiefly in contemplation of the eventual electrical operation of at least a part of the New Haven's main lines on an alternating current system that the railroad's engineers decided upon the single-phase equipment. This provision for the future is made possible by the feature of the adaptability of the new Westinghouse motor to either alternating current or direct current service.

Single-phase Car, Indianapolis and Cincinnati Traction Company

Westinghouse Single-phase Locomotive Used in Swedish Government Tests

The story of the tremendous advances of the past twenty years in electrical science is primarily the story of the wide application of the alternating current system. When George Westinghouse began the manufacture of electrical apparatus in 1886,

eighteen years after his invention of the air brake, the theoretical possibilities of electricity were fully appreciated, but little progress had been made in the solution of the problems of its practical use. The Westinghouse Electric and Manufacturing Company, through its early championship of the alternating current system of high voltage power transmission, at once assumed a prominent part in the development of the new industry, has grown in pace with it, and has consistently maintained to the present day its leadership in electrical inventive achievement. In its first year of business, it installed several small alternating current plants for generating electricity at high voltages to be transmitted over wide areas and transformed at various distributing points to the low voltages of electric lighting circuits. Two years later, it followed this conclusive demonstration of the feasibility of the alternating current system with the introduction of new types of Westinghouse motors by which alternating current was made available for power purposes. Its introduction, in 1889, of the rotary converter, for transforming at regular intervals along electric railway routes alternating current transmitted at high voltages from a central generating station into direct current for the trolley circuits, revolutionized electric traction methods. In New York City alone, in the Westinghouse electrical equipment of the elevated and subway lines of the Interborough Rapid Transit Company, eighteen Westinghouse alternating current generators of an aggregate capacity of about 140,000 horse-power, and eighty Westinghouse rotary converters of an aggregate capacity of about 160,000 horse-power, have been supplied. The brilliant success of the Westinghouse alternating current electric lighting installation won for the World's Columbian Exposition a notable place in the history of electricity. The ten 5000 horse-power

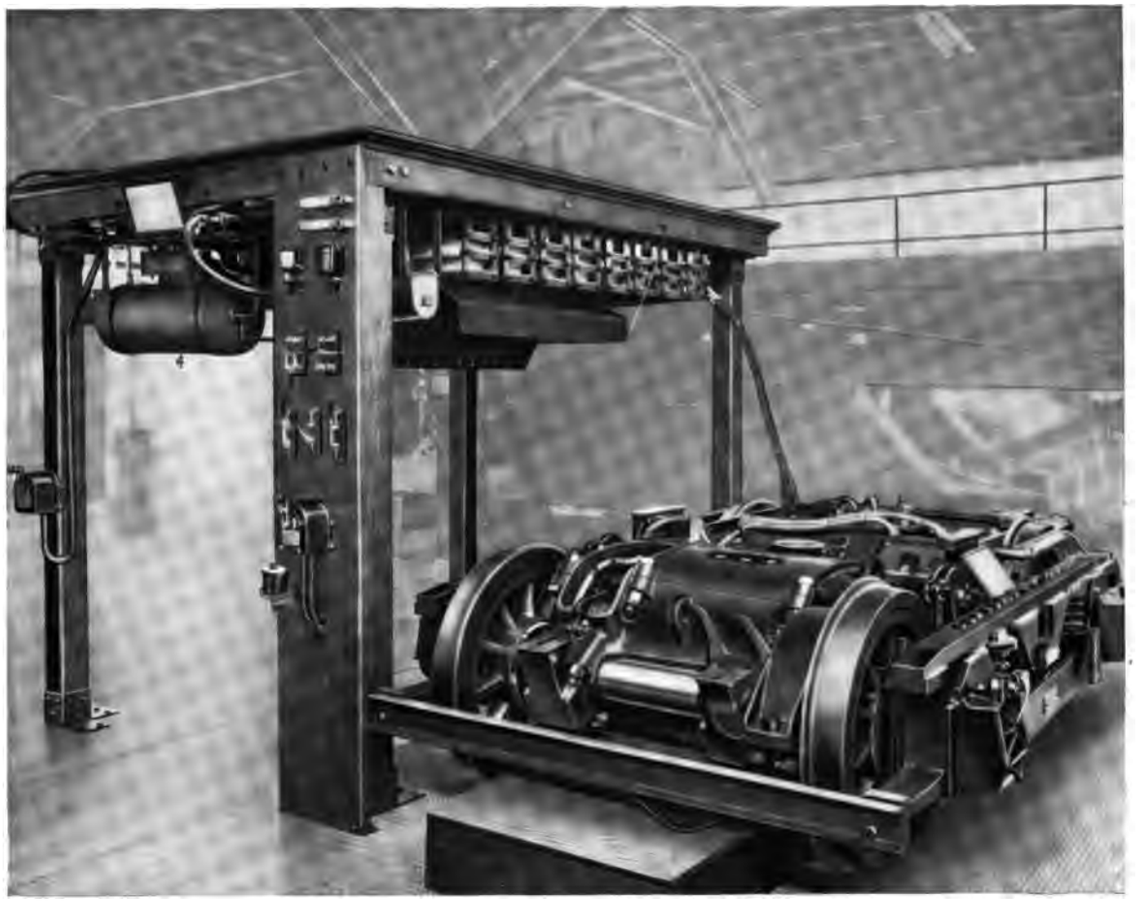
Westinghouse Single-phase Locomotive

Westinghouse alternating current generators installed in the first plant of the Niagara Falls Power Company, although of less than half the capacity of the record-breaking Westinghouse generators recently installed in the plant of the Ontario Power Company, on the Canadian side of the Falls, were, for a number of years, the largest generators in the world.

When it became apparent, in 1890, that the alternating current motor as then manufactured was not adaptable for railway service, the Westinghouse Company, after the acquisition of the electric manufacturing plant of the United States Electric Lighting Company, at Newark, New Jersey, began the manufacture of direct current railway motors, of which it has produced to date over 75,000, of an aggregate capacity of about 2,500,000 horse-power. It has long been evident, however, that the elimination of the expensive rotary converter sub-station is essential to the prospects of success of any plans for the general electrification of long-distance steam trunk railroads or the construction of long-distance interurban trolley lines in sparsely settled districts, and the Westinghouse Company, in its perfection of the single-phase railway motor, has completed its pioneer work in the evolution of the alternating current system by making such an elimination possible. The single-phase railway system promises, furthermore, great economy in line construction; a power transmission with generating stations 100 miles or more apart; economical speed control; and the operation of heavy trains by overhead trolleys in the place of the costly and dangerous third rails required in the direct current electric train service of the present day.

The Westinghouse electrical exhibits included, besides operative demonstrations of the single-phase traction system, and of the latest type of the Westinghouse electro-pneumatic control system for direct currrent railway service, displays of Westinghouse incandescent lamps, Nernst lamps, and Cooper Hewitt lamps, and electrical fittings, and an interesting group of heavy railway shop tools driven by Westinghouse motors. The single-phase exhibit showed the complete equipment of a 50-foot double truck car, with four 100 horse-power motors, and a form of electro-pneumatic control through auto-transformers and an induction regulator. The wheels of the trucks rested on greased rails and so provided sufficient frictional load on the motors to permit demonstrations of variable voltage operation. Alternating current from a 400-kilowatt Westinghouse rotary converter, running inverted, was received at 1100 volts through two oil-insulated step-up transformers placed near the car platform. The Westinghouse straight air brake equipment, with a motor-driven air compressor, formed a part of the operative exhibit, the motors and brakes being controlled by master controllers and operating air valves at each end of the car frame. Westinghouse single-phase motors are adaptable for operation over both alternating current and direct current lines when equipped with a combination control; but the control equipment for straight alternating current service was the only one exhibited, as the advantages of a simple and highly efficient control found in the alternating current system are particularly desirable in the frequent stops and variable speeds of city service, where direct current operation over established lines would otherwise be indicated. The standard

Multiple Control Switch



Operative Exhibit of the Westinghouse Direct Current Multiple Control System

Westinghouse single-phase equipment is designed for operation with a trolley circuit of from 3000 to 6000 volts.

The operative exhibit of the Westinghouse direct current multiple control system was of peculiar interest not only because of the various new features embodied in the design of the master controller, the reverser, the unit-switch group, and other important details of the control apparatus, but also in that the truck in operation, one designed for service on the Long Island Railroad, was probably the heaviest type constructed to that time, the total weight, exclusive of the motors, being 13,860 pounds. The control apparatus included the new rectangular unit-switch group, in which every switch is a circuit breaker, and the "bridging" arrangement of motor circuits, which permits a change from series to multiple operation without opening the circuit. The truck was equipped with two Westinghouse (type number 113) motors, each of 200 horse-power capacity, a slight modification of type number 86 in use on the subway cars of the Interborough Rapid Transit Company in New York.

The long experience of the Union Switch and Signal Company in the design and construction of electro-pneumatic signaling devices, and the unequaled experience of the Westinghouse Air Brake Company and the Westinghouse Traction Brake Company in the pneumatic operation of railway brakes and train signals, have been of great value

to the Westinghouse Electric Company in the development of its electro-pneumatic railway control systems.

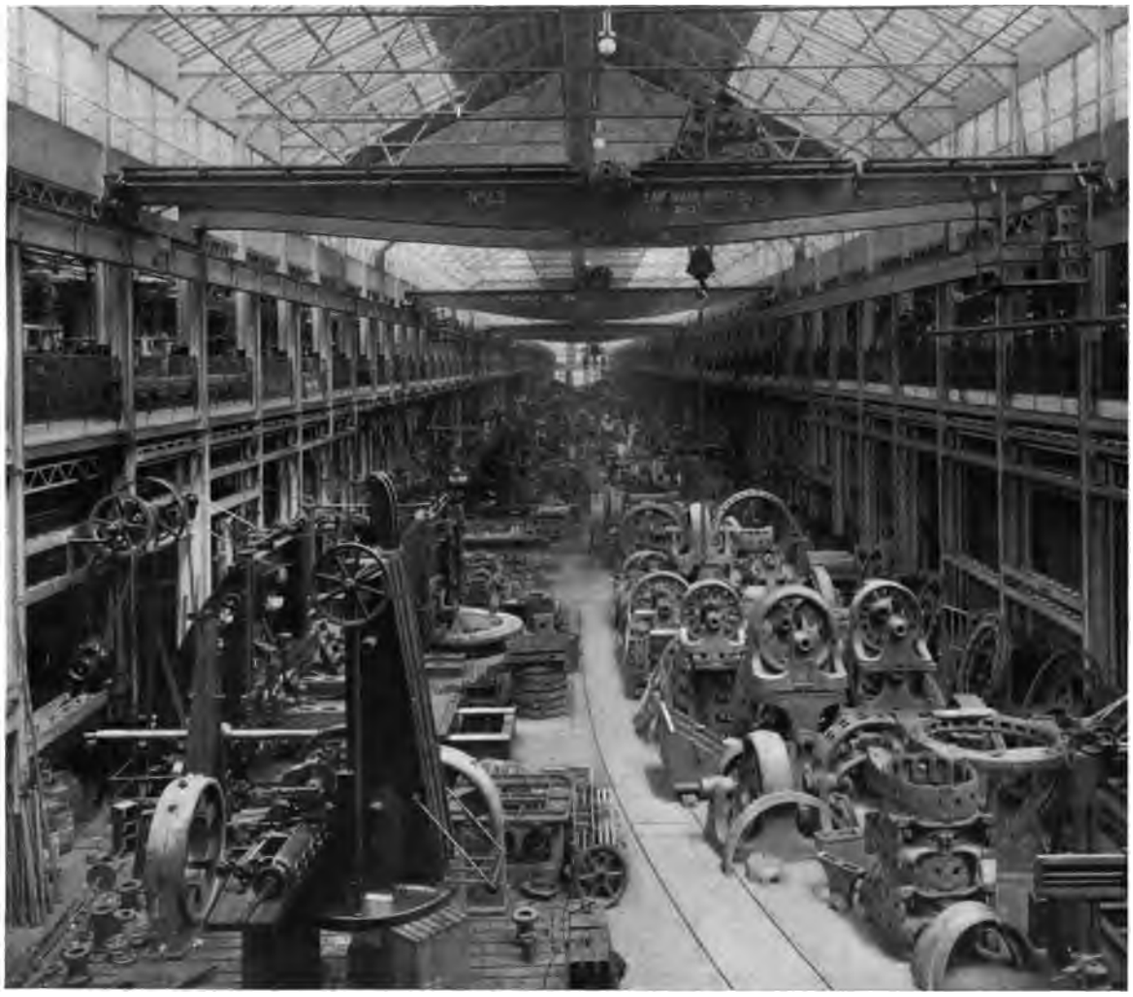
550 Horse-power Gas Engine Generating Unit

THE products of the Westinghouse Electric and Manufacturing Company to-day include every form of electrical apparatus required in railroad, lighting, or power service, ranging from the most delicate measuring instruments and the smallest commercial types of motor to the largest generators, motors and transformers ever constructed. The first of its present immense shops at East Pittsburg, twelve miles from the Pittsburg Union Station, was opened in 1895, with about 3000 employees. Extensions have been made from year to year, and the total ground area now occupied is 47 acres, and the available working floor space over 2,000,000 square feet. The company also operates works at Newark, New Jersey, Cleveland, Ohio, and Allegheny, Pennsylvania, and maintains district offices in twenty-two cities of the United States, and special foreign agencies in Mexico, Brazil, Chili and Japan. It sells also the well-known incandescent lamps of the Sawyer-Man Electric Company, of New York, and the standard electrical fittings of the Bryant Electric Company and the Perkins Electric Switch Manufacturing Company, of Bridgeport, Connecticut. The total number of employees in its East Pittsburg shops is now over 10,000, the total number of East Pittsburg employees being increased to about 12,000 by a working force of 2000 in the various departmental offices. In its branch factories at Newark, Cleveland and Allegheny, and in its tributary factories in New York and Bridgeport, 3000 additional employees bring the total number of its working force up to 15,000. The total floor space of its East Pittsburg shops, if laid out in the form of a continuous building of the average width of a large shop, would extend for five miles. The two chief buildings are the main machine shop, 1200 feet long and 370 feet wide, with five aisles and three galleries, fronted by a six-story office building; and the east machine shop, 1660 feet long and 230 feet wide, with three aisles and two galleries under one roof. This is said to be the largest building in the world devoted wholly to manufacturing purposes. The buildings are of steel and brick, roofed with slate, and in equipment and operation are designed to secure the highest productive efficiency, and to provide for

Thirty-five-foot Armature for One of the Seventeen 5000-kilowatt Westinghouse Generators for the Interborough Rapid Transit Company

a natural increase and development. The aggregate annual output of generators and motors is approximately 1,500,000 horse-power. Forty cars a day are required to haul raw material and finished product to and from the works.

Many of the largest early Westinghouse electrical contracts were for export, and the products of the factories of the Westinghouse Electric and Manufacturing Company and of the factories of its affiliated foreign companies are to be found in all parts of the world. Great Britain, which was for many years a large importer, is now supplied by the British Westinghouse Electric and Manufacturing Company, Limited, which was organized in 1899, and manufactures Westinghouse electrical apparatus in its immense new shops occupying a plot of 150 acres at Manchester, England. The Canadian Westinghouse Company, Limited ; the Société Anonyme Westinghouse, at its LeHavre works; and the Société Anonyme Westinghouse, of St. Petersburg, manufacture Westinghouse electrical apparatus for their respective territories. The Westinghouse Electricitäts-Actiengesellschaft, of Berlin, sells Westinghouse electrical apparatus in Germany, Austro-Hungary, the Balkan States, Greece and Turkey.



One of the Large Aisles in the Main Building of the Westinghouse Electric Works at East Pittsburg

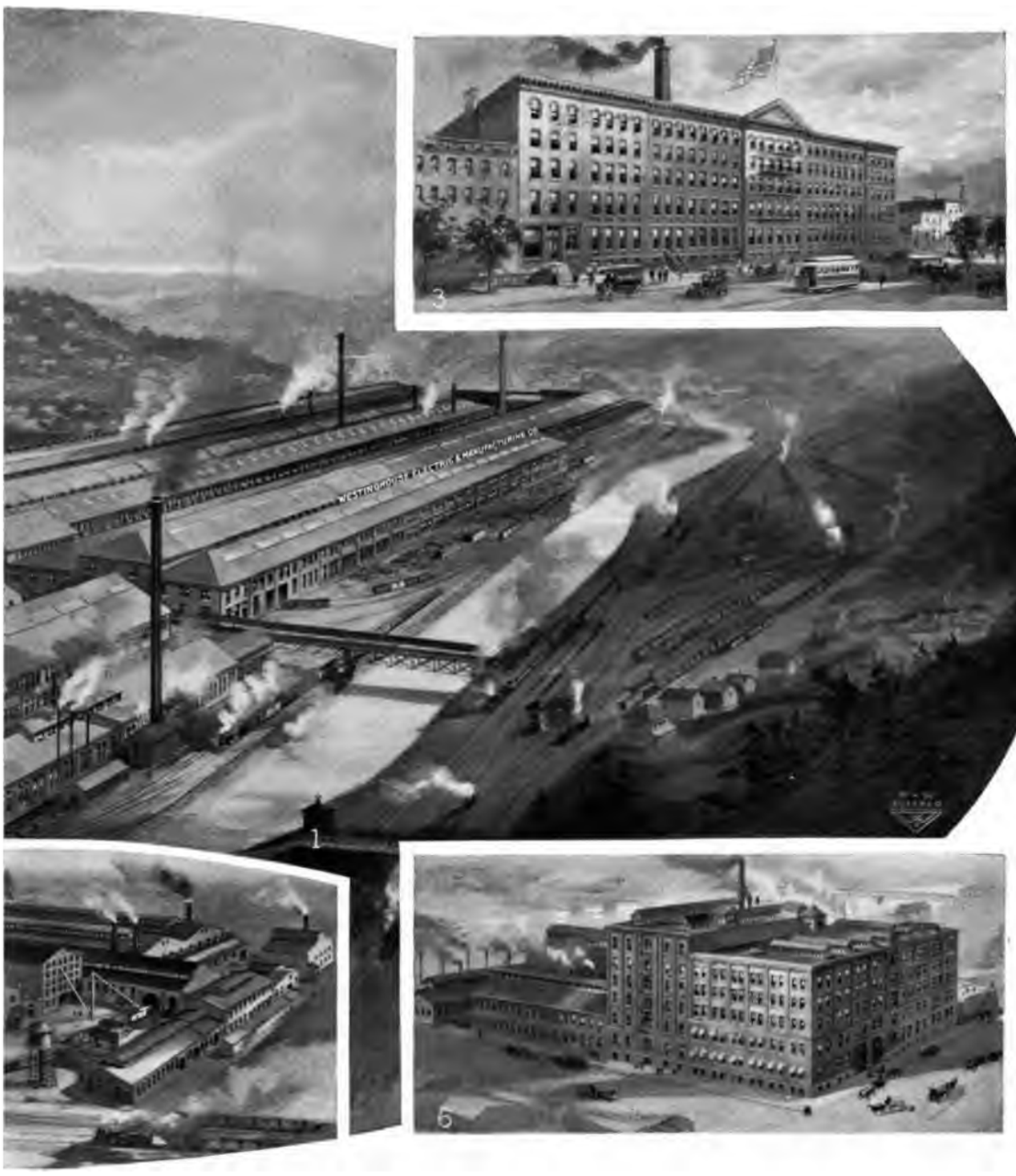
Newark Works
of the Westinghouse
Electric & Mfg. Co.

Works of
The Bryant Electric Co. and
The Perkins Electric Switch
Manufacturing Co.,
Bridgeport, Conn.

East Pittsburg.

The Westinghouse Machine Co.'s Works

Cleveland Works of the Westin



Works of
Sawyer-Man Electric Co.,
New York, N. Y.

Original Works of the
Westinghouse Electric
& Mfg. Co.
Now occupied by
R. D. Nuttall Co.,
and Nernst Lamp Co.,
Pittsburg, Pa.

Pennsylvania

Westinghouse Electric & Mfg. Co.'s Works

nghouse Electric & Mfg. Co.

THE brilliant lighting of the Westinghouse pavilion by Nernst and Cooper Hewitt lamps afforded an attractive display of two important American Westinghouse products which have earned a place in the general field of artificial illumination no less notable than that of Westinghouse brakes and signals in the field of railway safety appliances or of the Westinghouse alternating current system in the field of electric traction. The Nernst Lamp Company, of Pittsburg, organized by George Westinghouse in 1901, has played a leading part in the rapid commercial development of Dr. Nernst's invention, and to those of the delegates to the congress who had not become familiar with the new lamp in Europe, it was one of the distinct novelties of the Washington exhibit. Its manifest superiority over all other forms of lamp for the artistic lighting of large buildings was well illustrated in the dazzling effect of the grouping of one hundred and thirty three-glower lamps in the Westinghouse pavilion, and its high efficiency was demonstrated at the exhibit with a testing rack in which the current consumption of an ordinary 50 candle-power incandescent lamp was shown to be over twice that of a Nernst lamp of the same radiance—comparative figures which have encouraged the wide adoption of the Nernst lamp by central station lighting companies throughout the United States, for use on their circuits wherever alternating current is available.

Six-glower Nernst Lamp

The Nernst lamp is made in units ranging in capacity from 20 to 500 candle-power, and differs from the ordinary carbon filament incandescent globe in that its light-giving filament, or glower, is a porcelain composite of rare earths, which is maintained at an extreme incandescense, indoors or outdoors, without the aid of a vacuum, so that the globe may be freely removed for cleaning it, or renewing the filaments. Its beautiful white light has recommended its adoption in many large public buildings, and the Pennsylvania, the Michigan Central, the

The Nernst Lamp Wattmeter Test

Long Island, the Wabash, and other leading American railroads have used it extensively for depot and office lighting. Regarded at first as destined to find a special field of service in the demand for lamps of a size between that of the ordinary incandescent globe and that of the arc light, it is rapidly invading also the domain of the low-efficiency carbon incandescent globe on the one hand and the unsteady and unornamental arc lamp on the other. About 5000 glower units were used in lighting the fine art galleries at the Louisiana Purchase Exposition.

Cooper Hewitt Lamp—Type II

The Pittsburg factory of the Nernst Lamp Company has a working floor space of over 100,000 square feet, and district offices are maintained throughout the United States.

The exhibit of the Cooper Hewitt mercury vapor lamp presented to many of the delegates the first opportunity for a close study of this important American invention and to all the snapshot photographs of visitors taken under a small "skylight" outfit of the mercury tubes gave interesting evidence of the high quality of the mercury vapor light. The Cooper Hewitt Electric Company's display included also a single-phase 60-cycle Cooper Hewitt mercury vapor converter, of 30 amperes capacity, complete with switchboard, voltmeter, ammeter, and regulator, for charging storage batteries from alternating current circuits—a cheaper and simpler apparatus for transforming alternating current to direct current for such a purpose than the rotary converter or motor-generator set.

The Cooper Hewitt lamp consumes only a half watt of current per spherical candle-power, proportionately about one-half the current required for the electric arc lamp and one-sixth that required for ordinary incandescent globe lighting. It consists of a glass vacuum tube containing a small quantity of metallic mercury, its light being started by tilting the tube, either mechanically or automatically by means of a magnetic attachment. This permits the flow of mercury from one end to the other in a small stream which momentarily connects the electrodes at the ends; the resulting arcing of the current at once increases the pressure of the mercury vapor, which becomes incandescent and remains luminous until the current supply is cut off. It is furnished for either direct current or alternating current circuits. The burning life of the tubes is several thousand hours. The light produced, because of the absence of red rays in the mercury

Cooper Hewitt Mercury Vapor Converter

Nuttall Electric Traction Gear

spectrum, is less fatiguing to the eye than any other artificial light. The diffusion of light from long tubes prevents the formation of confusing shadows. Wherever the indication of color values is of secondary importance, as in the lighting of railroad and steamship freight terminals, piers and warehouses, factories and machine shops, printing establishments, business offices and drafting rooms, its broad features of efficiency and economy clearly dictate its use.

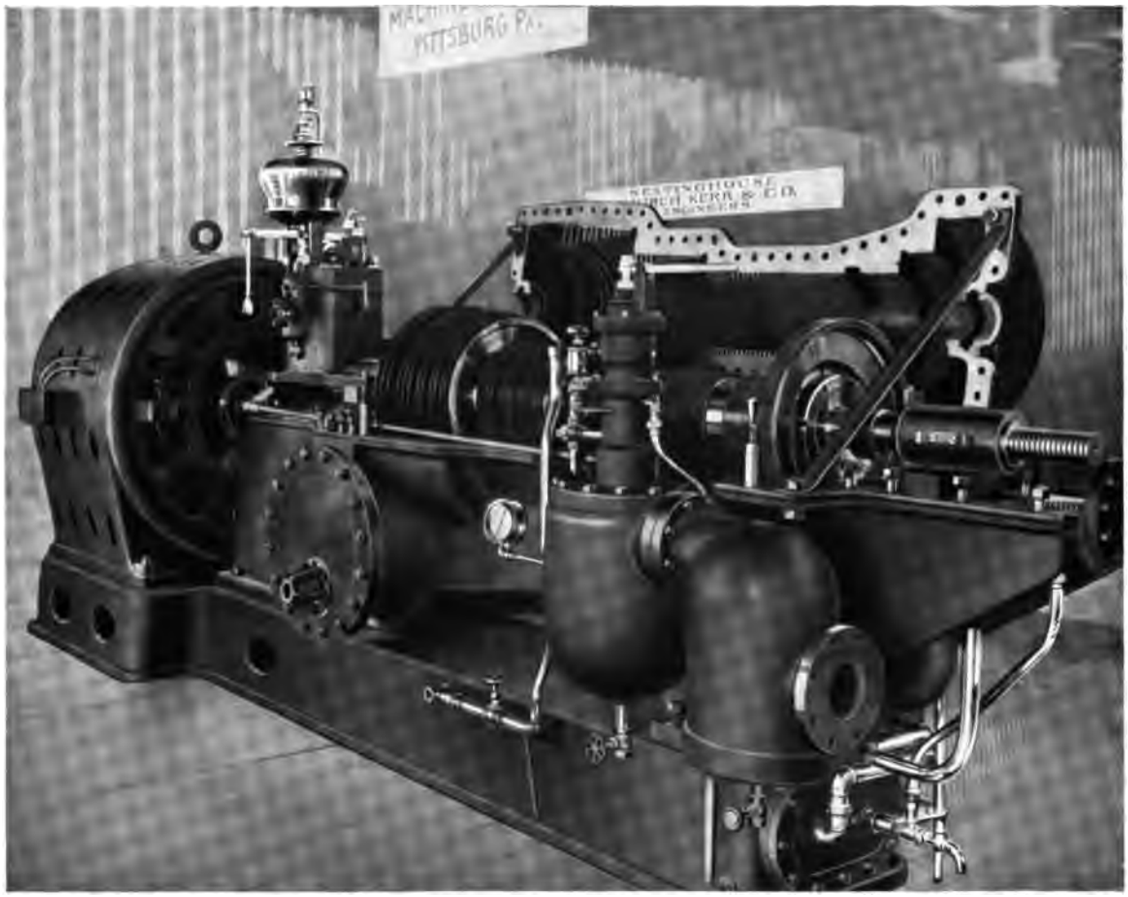
THE R. D. Nuttall Company, manufacturers of gears, pinions, and trolleys, exhibited their products in actual equipment on cars and trucks displayed in various parts of the exhibition grounds at Washington, and in the pneumatically-operated pantagraph bow trolleys of the Westinghouse single-phase locomotive which were raised and lowered by compressed air, shown at East Pittsburg. It maintains district offices in seven American cities, and is represented in Brussels and Milan.

The trip of the delegates to East Pittsburg directed attention to another important Westinghouse company, the Pittsburg Meter Company, organized in 1884, whose large works adjoin the shops of the Westinghouse Machine Company. This company manufactures Keystone water meters, Westinghouse wet gas meters, Westinghouse dry gas meters, Westinghouse proportional gas meters, and water and gas meter provers. These meters are very extensively used by many of the leading railroads throughout the United States, Canada and abroad.

Another widely-known Westinghouse product is the Sawyer-Man incandescent lamp. The Sawyer-Man Electric Company was organized in 1896, and its works now occupy a large and commodious building in the center of New York City. The company has branches in twenty of the principal cities in the United States.

IN view of the impetus given to railway electrification projects by the demonstration of the remarkable economies of the turbo-electric power plant, and by the advent of the single-phase traction system and other important electrical developments, the steam turbine might be characterized as the stationary prime mover destined to supplant the traveling steam engine. The railway engineer's interest in central station equipment, since the adoption of the turbo-electric system for the operation of the transformed local and terminal lines of London, New York, and other large cities, has centered in the steam turbine, and the 600 horse-power Westinghouse-Parsons turbine set up opened for inspection in the Westinghouse pavilion was studied closely by those delegates who never before had opportunity of seeing the interior construction of a rotary engine of the type which has surpassed all others in efficiency and in the number and aggregate capacity of units

The Trafford City Foundries of The Westinghouse Machine Company



The 600 Horse-power Westinghouse-Parsons Steam Turbine Unit

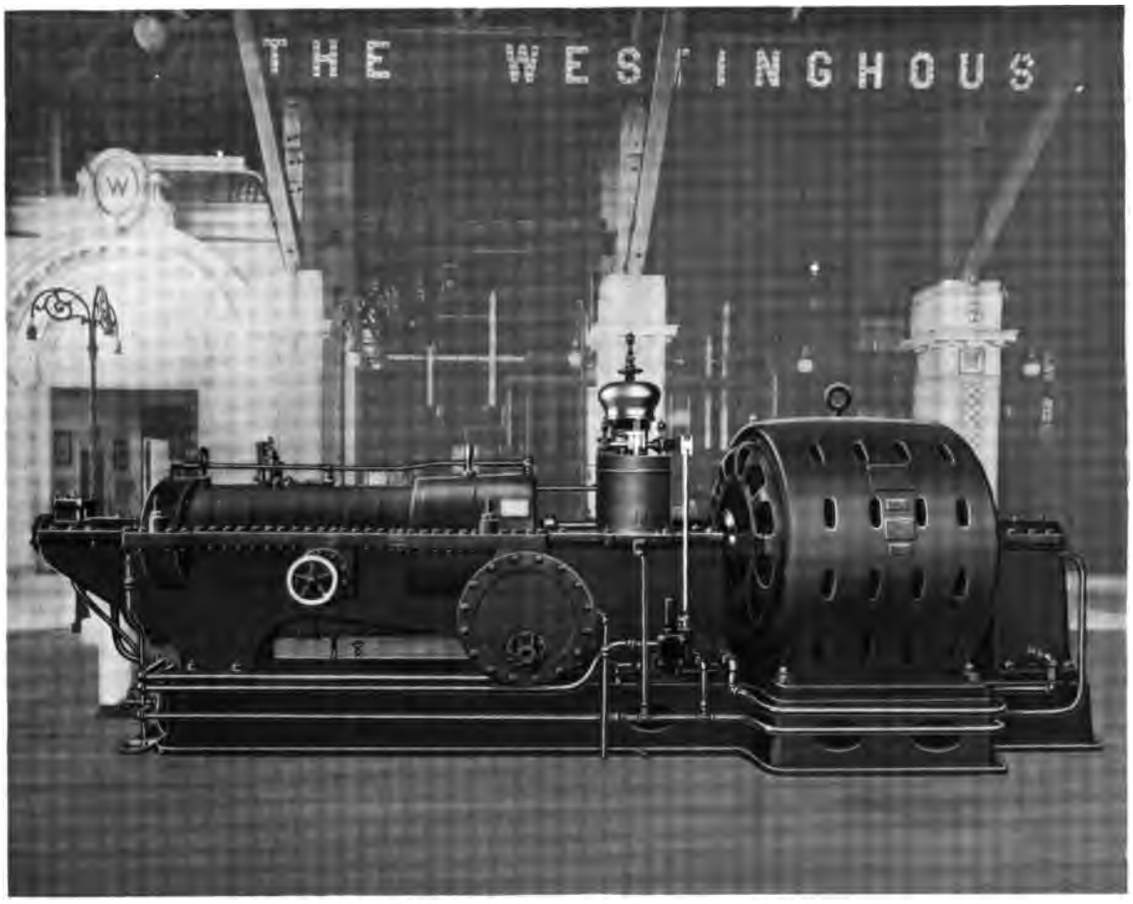
installed. The turbine on exhibit, although one of the small sizes constructed by the Westinghouse Machine Company, which has led the world in the manufacture of turbines of record capacity, was interesting as representative of such large Westinghouse turbine installations as the 70,000 horse-power Chelsea station of the London Metropolitan District Railway; the smaller Neasden station of the London Metropolitan Surface Railway; and the 30,000 horse-power station at Long Island City, designed for an ultimate capacity of 60,000 horse-power, to operate in conjunction with a similar station on the New Jersey shore in supplying current for the Pennsylvania Railroad's New York terminal tunnels and the electrified portions of the Long Island system.

The Westinghouse Machine Company, which has manufactured more steam engines than any other company in the world, introduced the steam turbine in America in 1896, and the four 600 horse-power Westinghouse turbine generating units in the works of the Westinghouse Air Brake Company have been in service for six years with practically no cost for repairs. During the past two years, the turbine has supplanted to a great extent the reciprocating engine in new power and lighting installations, and among the notable contracts awarded to the Westinghouse Machine Company and the Westinghouse Electric and Manufacturing Company for turbines and turbo-generators have been those of the Brooklyn Rapid Transit Company, for two units of a guaranteed maximum

capacity of 15,000 horse-power each; of the New York Edison and the Brooklyn Edison lighting companies, for three units of the same capacity; and of the Philadelphia Rapid Transit Company, which has already in service six Westinghouse turbine units of an aggregate maximum capacity of 18,000 horse-power, and has contracted for three additional units of a maximum capacity of about 12,000 horse-power each, for its new power plant under construction on the Delaware river, which will accommodate ultimately eight units of the same capacity. The turbine unit on exhibition at Washington was 18 feet 6 inches long, with the generator attached, 4 feet 6 inches wide, and 7 feet 6 inches high, and was designed to operate at a steam pressure of 150 pounds, with a vacuum of from 27 to 28 inches. The revolving field turbo-generator, with a rated capacity of 400 kilowatts, was designed to deliver a 60-cycle three-phase alternating current at 440 volts, 7200 alternations. This exhibit unit was of special interest in that it was of the exact size and type of the little 600 horse-power Westinghouse-Parsons turbine unit which ran under load continuously at the Louisiana Purchase Exposition from the morning of June 20, to the morning of December 2, 1904, maintaining a speed of 3600 revolutions a minute for a total of 3962 hours. When that turbine was formally stopped and opened for inspection on the morning after the close of the St. Louis Fair, in the presence of Exposition engineers, it was found to be in perfect condition—even the bearings showing the tool marks as when it left the factory. During the five and a half months that it had been in operation it had supplied current for light and power throughout the comprehensive Westinghouse exhibits in the machinery, electricity, and transportation palaces. From 8.30 o'clock in the morning to 10.30 o'clock in the evening, the load carried throughout its long run had varied from twenty-five per cent. underload to twenty-five per cent. overload. The total load carried was estimated at 1,216,475 kilowatt hours, and the total number of revolutions—855,792,000—approached the billion mark. During this long and continuous run the

10,000 Horse-power Westinghouse-Parsons Turbine Unit in the New York Subway Power Plant

The Steam Turbine Plant at the Westinghouse Air Brake Works
The First in America



The 600 Horse-power Westinghouse-Parsons Steam Turbine Unit, which ran continuously under load for 3962 Hours at the St. Louis Exposition

28-inch field of the turbo-generator revolved at a peripheral speed of 7000 miles every twenty-four hours, or over one-fourth as fast as the earth revolves. There have been instances of long continuous runs of piston engines, but it is obvious that the steam turbine, with its single rotating motion, and with the entire absence of stresses incident to the inertia of heavy reciprocating parts, might with an insignificant amount of attention run continuously for a number of years with no impairment of its mechanical condition or efficiency.

The products of the Westinghouse Machine Company, whose main shops adjoin those of the Westinghouse Electric and Manufacturing Company at East Pittsburg, include also automatic high-speed simple and compound steam engines, marine type compound steam engines, and Westinghouse-Corliss reciprocating steam engines; single-acting and double-acting gas engines, adaptable for natural, illuminating, producer, or blast furnace gases; and the Roney mechanical stoker, an automatic device for eliminating the expense and inefficiency of firing boiler furnaces by hand, which effects a large fuel saving and has been widely adopted in central station installations of the best type. The company was the first to put upon the market the non-condensing compound steam engine. Among its recent reciprocating engine installations are the 40,000 horse-

power station of the Metropolitan Street Railway System, at Kingsbridge, New York City, and the 70,000 horse-power Waterside station of the New York Edison Company, where eleven Westinghouse-Corliss three-cylinder compound engines, rated at 6500 horse-power, with a demonstrated efficiency of 95.2 per cent., frequently maintain a load of 10,000 horse-power. The company was organized in 1881, and its properties to-day, including foundries at Trafford City, near East Pittsburg, and stoker works at Craigin, Illinois, and Attica, New York, have an area of about fifty acres and are operated by a force of 3500 men.

The Boston Terminal—South Station
Westinghouse Church Kerr & Co., Engineers for Equipment

THE Washington exhibits of Westinghouse Church Kerr & Company comprised large photographic illustrations, drawings and specifications of important engineering work.

This organization—unlike other Westinghouse corporations—has no manufacturing or trade interests and, therefore, nothing to sell. Its activities are directed toward designing and constructing properties, mainly railway, power, electric, industrial and hydraulic. Its engineering work is characterized by the completeness with which it is undertaken and executed. To this end a large and most versatile organization has been developed and perfected for the handling of all branches of engineering: civil, mechanical, electrical and others—thus enabling adequate and simultaneous attention to be given to all classes of service that an extensive undertaking may involve.

Exterior—The Long Island City Steam Turbine Plant of the Pennsylvania, New York and Long Island Railroad. Westinghouse Church Kerr & Co., Engineers

Interior—The Long Island City Steam Turbine Plant of the Pennsylvania, New York and Long Island Railroad. Three 10,000 horse-power Westinghouse Generating Units. Westinghouse Church Kerr & Co., Engineers

The work of creating properties from their inception to readiness for commercial operation is carried on by this company directly for the benefit of the client through methods which involve systematic accuracy, dispatch, economy and effectiveness; saving for him the advantages usually accruing to the competent contractor and other substantial benefits as well. The same facilities may be drawn upon for consulting engineering service.

Atlanta Water and Electric Power Co., Chattahoochee River Power Plant
Westinghouse Church Kerr & Co., Engineers

No invariable way of doing work has been established, the aim being to supplement from time to time existing facilities of others in undertaking unusual or additional work, or to provide the whole service that is required by those who are without organization for design and construction.

American Car & Foundry Co., Berwick, Pa., Shops
Westinghouse Church Kerr & Co., Engineers

The organization has been perfected by gradual growth and experience during the period in which enterprises have advanced in magnitude and character from those that were leisurely undertaken a quarter of a century ago to the large and complex operations of the present day which must be conducted with a diligence and effectiveness commensurate with their size and importance.

A few important undertakings executed by Westinghouse Church Kerr & Company of especial interest are:

American Car & Foundry Company, Detroit, Michigan, and Berwick, Pa.—Structures designed and equipment designed and installed.

Atlanta Water & Electric Power Company — Hydro-electric development and high tension transmission.

The Boston Terminal Company — Entire equipment of South Station.

The Detroit Edison Company—Design and construction of a turbine station with ultimate capacity of 100,000 horse-power.

Terminal Railroad Association of St. Louis, St. Louis Union Station
Westinghouse Church Kerr & Co., Engineers

Detroit Edison Company, Detroit, Mich., Delray Power Plant
Westinghouse Church Kerr & Co., Engineers

Lackawanna & Wyoming Valley Railroad Company—Entire design and construction.

The Long Island Railroad Company—Electrification of western lines.

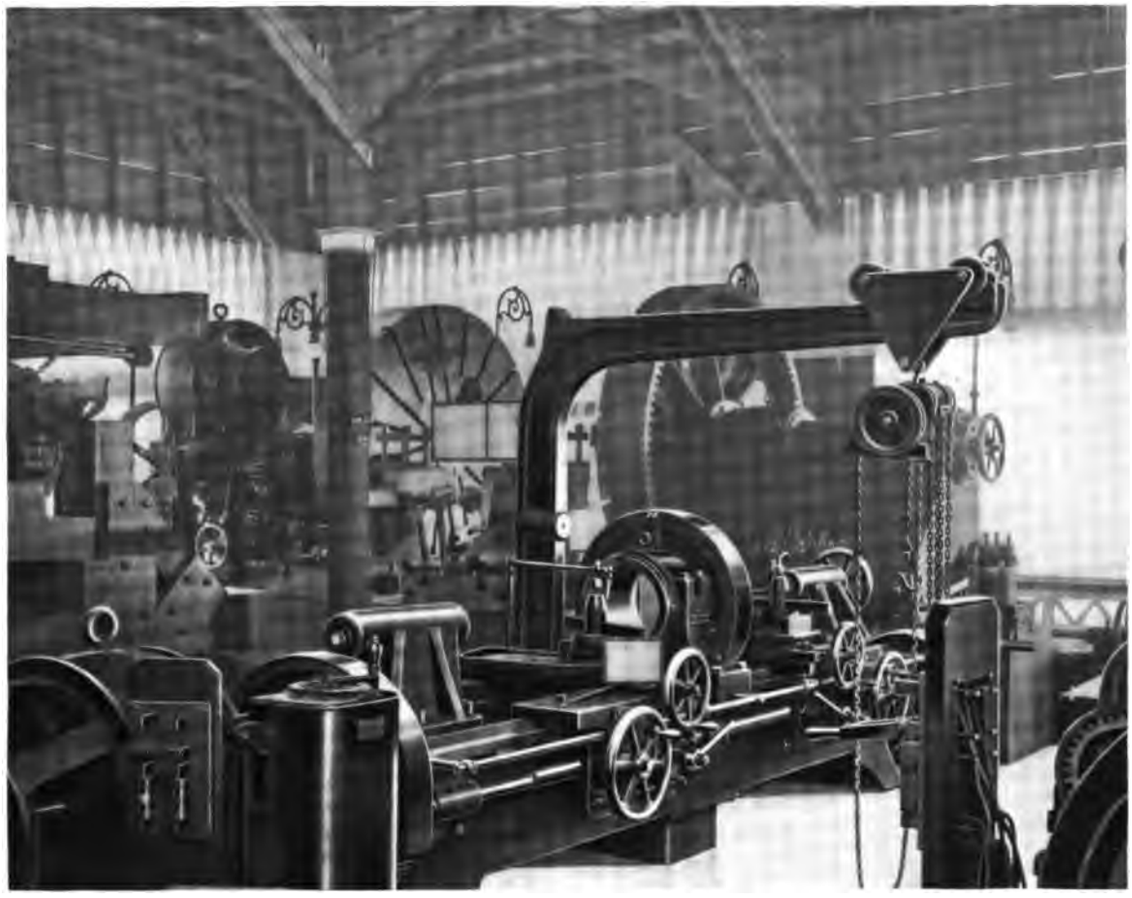
New York City Railway Company—Electric railway power station, 50,000 horsepower.

Pennsylvania Railroad Company—Engineering and construction in connection with new tunnel and terminal improvements in New York City.

The Pittsburgh & Lake Erie Railroad Company—Entire equipment of Union Station, Pittsburgh, and mechanical equipment of McKee's Rocks Pennsylvania shops.

Terminal Railroad Association of St. Louis—Remodeling and enlarging equipment for St. Louis terminal and East St. Louis shops.

New York City Railway Company, Kingsbridge Power Plant
Westinghouse Church Kerr & Co., Engineers



A Corner in the Motor-driven Machine Tool Exhibit

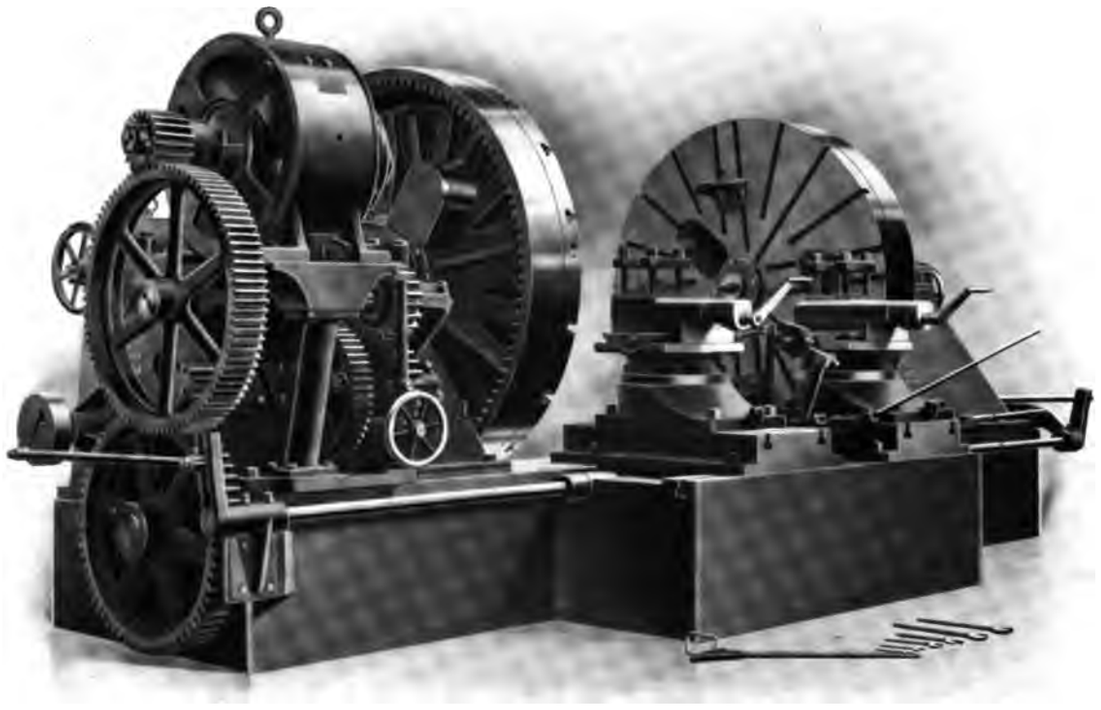
THE Westinghouse display would not have been complete without the exhibit of motor-driven machine tools, to which one entire corner of the pavilion was devoted. The economy and flexibility of the electric drive being nowhere more appreciated than in railway shop service, in which the Westinghouse motors have acquired so high a reputation, more than ordinary interest was displayed in the tool exhibit. The Niles 90-inch locomotive driver lathe included in this exhibit was the largest shop tool shown on the Monument grounds, and a notable feature of all the tools displayed was their special design for electric drive, with strong frames provided with platform or bedplate extensions for motor mounts, and shafts or clutch gearings so arranged as to permit a variation of speeds, within sufficiently wide ranges, with either constant-speed or variable-speed motors. They were all driven by Westinghouse type S shunt-wound motors, operating on a 220-volt direct current circuit.

Westinghouse direct current and alternating current motors for industrial work are built in all forms and styles, and in sizes ranging from a capacity of one-sixth of a horse-power to a capacity to meet any requirement of the heaviest service. The aggregate output of Westinghouse electrical apparatus of small size is equal to the output in large machines, and every feature of small motor design and construction is the expression of the same highly trained engineering skill and scientific process that have contributed so

largely to the general success of all Westinghouse industries. The reliability of apparatus so built is proportionately as important a commercial factor in industrial motor service, where a few shut-downs may entail a loss greater than the entire initial motor expense, as in the marketing of great generating units, where only the highest types of engineering achievement are acceptable.

The use of electricity in the machine shop has helped railroad progress not only in the economies of the individual tool drive, but in the inestimable advantages of electric crane service, and in the conveniences of electric lighting. Outside of the shops, motor-driven turntables and transfer tables are found in rapidly increasing numbers; the motor-driven fan is in popular use to clear the atmosphere of blacksmith forges and roundhouses; the electric drive is facilitating the work of dredging and digging; and great reductions in the cost of mine operation have been effected by the motor-driven pump and hoist. In all these classes of service, Westinghouse motors have found a wide field of usefulness. In alternating current service, the Westinghouse type C motor is the original and by far the best known polyphase induction motor in the world, and the type F motor, a modification of type C permitting a speed variation through the use of secondary resistance, is especially adapted to all work where heavy loads must be brought gradually up to speed. One of the most interesting recent installations of this type was in the Cascades pumping plant at the Louisiana Purchase Exposition, where three 2000 horse-power motors, the largest induction motors ever built, driving three centrifugal pumps of a capacity of 35,000 gallons a minute each, were operated on a 6000-volt three-phase circuit of 3000 alternations, and started, through a connection to grid resistances, by hand controllers of 54 steps.

The Niles 90-inch locomotive driving wheel chucking lathe exhibited at Washington, weighs about 110,000 pounds, and is the most powerful machine of its class ever constructed. It was operated by a 40 horse-power motor, of from 490 to 980 revolutions a minute, gear changes permitting a variation in cutting speeds of from 10 to 25 feet a minute on all diameters of wheels from 48 to 84 inches on the tread. The tool rests were of very massive design; the face plates, driven by internal gears, were provided with openings for the crank pins, so that wheels might be chucked close; and the movable head was traversed by a separate 5 horse-power motor, of 1050 revolutions, mounted on an extension of the bedplate and geared to the shaft. The diameter of the face plates was 90 inches, the distance between them variable between 6 feet 8 inches and 9 feet, and the swing over bed 92 inches. Through the simplicity of the motor control, the rigidity of construction, and the improvements in the chucking device, by which tires were held solidly against the face plates, this machine has a capacity of six pairs of tires in



Niles 90-inch Driving Wheel Chucking Lathe—Operated by Westinghouse Motors

a day of ten hours, or more than three times that of driving wheel lathes of old design. Another interesting Niles tool in the Westinghouse exhibit was a heavy double axle lathe, designed for turning simultaneously both ends of the heaviest axles, with a center axle drive. This machine was operated by a 20 horse-power motor of from 340 to 1200 revolutions a minute. It was mounted on an extension of the bed-plate, and equipped with a crane, an automatic feed release, and a rapid hand traverse. The diameter of the hole in the central head was 12½ inches, the maximum distance between centers being 8 feet.

Other machine tools in operation were a Putnam rapid reduction lathe designed for roughing out pieces up to 19 inches in diameter, with special devices for holding the work firmly under the deepest cuts with modern machine tools; and a Sellers universal grinding machine, for all sizes and shapes of tools. The lathe was driven by a 50 horse-power motor of from 500 to 1000 revolutions a minute, and the grinding machine was driven by a 7½ horse-power motor of 975 revolutions a minute.

THE visit of the delegates to the Westinghouse shops at East Pittsburg on May 16 is memorable for the exhibit of a 1350 horse-power single-phase freight locomotive, the first great single-phase locomotive ever constructed; and of a model freight train of fifty steel gondola cars, equipped throughout with the improved Westinghouse air brake triple valve, the Westinghouse friction draft gear, the American brake slack adjuster, and the Westinghouse automatic air coupler. The improved triple valve was exhibited also in the brake equipment of a seventy-car train in a rack arrangement to demonstrate the comparative performances of the improved and the ordinary types of valve. The single-phase locomotive was shown in operation running light and hauling the fifty-car train, and the track exhibition included also train collisions at comparatively high speeds arranged to demonstrate the great capacity of the Westinghouse friction draft gear in absorbing and dissipating the shocks of impact and reaction.

The electric locomotive exhibited was the most powerful ever constructed to take current from an overhead wire, and the first alternating current locomotive built for use in America. It was divided into halves, designed for operation separately if desired, each half equipped with three 225 horse-power motors. With the motors at nominal full load, the drawbar pull at ten miles an hour was 50,000 pounds, but dynamometer tests in hauling the fifty-car train, weighing light 2,250,000 pounds, developed on several occasions a steady drawbar pull of from 60,000 to 65,000 pounds, and momentary efforts as high as 100,000 pounds without slipping wheels. It was operated from a trolley circuit of 6600 volts, the reduced motor voltage being variable between

Westinghouse Single-phase Locomotive Hauling 50-car Freight Train

140 and 325 volts by a form of induction regulator control. The drivers were 60 inches in diameter, the unit was 45 feet long over all, 9 feet 2 inches wide, and 17 feet high, and the weight complete was 135 tons.

The triple valve test rack represented two seventy-five-car trains, each similarly equipped with standard freight brake cylinders and auxiliary reservoirs, piping and fittings, the train represented by the apparatus in front using the standard triple valve and the rear row train the improved valve. The train pipes were entirely separate, each train having its own main reservoir and operating valve, the two operating valves, however, being so connected that it was impossible to move one handle without moving the other. The brakes on both chains were thus applied simultaneously and with the same reduction of brake pressure. The cylinder and reservoir sets were placed vertically, and the push-rod holders in the front were painted blue and those in the rear red, so that it was easy to watch the application of the brake travel through the trains, and to distinguish between them. An electro-pneumatic device attached to the brake cylinder of the seventy-fifth car on each train rang an electric bell near the engineer's brake valve when the cylinder pressure on that car had reached 20 pounds, so that the length of time required for applications on trains equipped with either the old or the improved valves was accurately measured. The tests showed the comparative operation of the two types of valve in service and in emergency applications, and in releasing the brakes.

The improved Westinghouse triple valves reduce the time of service application on a fifty-car train practically one-half, without danger of undesired emergency application, and preserve all the features of sensitiveness of graduation obtained in the standard valve. They provide also an even recharge of auxiliary reservoirs, and a retarded release of the brakes on the forward end of the train so that, as desired, the rear brakes may be released first, or all the brakes almost simultaneously —an improvement of great value in preventing the parting of trains.

THE WESTINGHOUSE COMPANIES

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American Brake Company, St. Louis, Mo.

The British Westinghouse Electric and Manufacturing Company, Limited, London and Manchester, England.

The Bryant Electric Company, Bridgeport, Conn.

Canadian Westinghouse Company, Limited, Hamilton, Ontario.

Cooper Hewitt Electric Company, New York, N. Y.

The East Pittsburg Improvement Company, Pittsburg, Pa.

Nernst Lamp Company, Pittsburg, Pa.

R. D. Nuttall Company, Pittsburg, Pa.

The Perkins Electric Switch Manufacturing Company, Bridgeport, Conn.

Pittsburg Meter Company, East Pittsburg, Pa.

Sawyer-Man Electric Company, New York, N. Y.

Security Investment Company, Pittsburg, Pa.

Société Anonyme Westinghouse, Le Havre, France.

Société Anonyme Westinghouse, St. Petersburg, Russia.

The Traction and Power Securities Company, Limited, London, England.

The Union Switch and Signal Company, Swissvale, Pa.

The Westinghouse Air Brake Company, Wilmerding, Pa.

Westinghouse Automatic Air and Steam Coupler Company, St. Louis, Mo.

The Westinghouse Brake Company, Limited, London, England.

Westinghouse Church Kerr & Company, New York, N. Y.

Westinghouse Electricitäts-Actiengesellschaft, Berlin, Germany.

Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.

The Westinghouse Foundry Company, Pittsburg, Pa.

Westinghouse Inter-Works Railway Company, Pittsburg, Pa.

The Westinghouse Machine Company, East Pittsburg, Pa.

Westinghouse Traction Brake Company, Wilmerding, Pa.